

**REPORT DOCUMENTATION PAGE**Form Approved  
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

<b>1. REPORT DATE (DD-MM-YYYY)</b> 6 February 2003		<b>2. REPORT TYPE</b> Technical Abstract		<b>3. DATES COVERED (From - To)</b>	
<b>4. TITLE AND SUBTITLE</b>  An Automated Fluid-Structural Interaction Analysis of a Large Segmented Solid Rocket Motor				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
				<b>5d. PROJECT NUMBER</b> 1011	
6. AUTHOR(S)  Brian W. Rex, Qunzhen Wang, Daron Isaac				<b>5e. TASK NUMBER</b> 00TN	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>  ATK Thiokol Propulsion Brigham City, Utah				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFRL-PR-ED-AB-2003-034	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>  Air Force Research Laboratory (AFMC) AFRL/PRS 5 Pollux Drive Edwards AFB CA 93524-7048				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S NUMBER(S)</b> AFRL-PR-ED-AB-2003-034	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b>  Approved for public release; distribution unlimited.					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b>  <div style="text-align: right; font-size: 2em; font-weight: bold;">20030320 043</div>					
<b>15. SUBJECT TERMS</b>					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b> Sheila Benner
<b>a. REPORT</b> Unclassified	<b>b. ABSTRACT</b> Unclassified	<b>c. THIS PAGE</b> Unclassified	A		<b>19b. TELEPHONE NUMBER</b> (include area code) (661) 275-5693

FILE

MEMORANDUM FOR PRS (Contractor Publication)

6. FROM: PROI (STINFO)

10 Feb 2003

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-AB-2003-034**  
Brian W. Rex, Dr. Qunzhen Wang, and Daron Isaac (all ATK Thiokol Propulsion) "An Automated  
Fluid-Structural Interaction Analysis of a Large Segmented Solid Rocket Motor" (abstract only)

55332  
Ruderman

AIAA/ASME/ASEE Joint Propulsion Conference  
(Huntsville, AL, 20-23 Jul 2003) (Deadline: none listed)

(Statement A)

# An Automated Fluid-Structural Interaction Analysis of a Large Segmented Solid Rocket Motor

Brian W. Rex , Dr. Qunzhen Wang, and Daron Isaac

ATK Thiokol Propulsion  
Brigham City, Utah

## ABSTRACT

A new analysis procedure has been used to evaluate the propellant grain/flow stability of a new, five segment Space Shuttle solid rocket booster. The fluid-structural interaction (FSI) analysis of the ETM-3 motor used PYTHON, a powerful programming language, and FEM BUILDER, a pre- and post processor developed by ATK Thiokol Propulsion, to automatically couple the ABAQUS structural solver with FLUENT, the CFD solver. This iterative process automatically used the results of one solver as the inputs to the other solver until convergence to a solution was obtained.

The ETM-3 motor was basically an RSRM motor with an additional center segment added. The additional segment and greater nozzle diameter increased mass flow and mach number in the motor. Because of this harsher flow environment, it was necessary to conduct a detailed FSI analysis to ensure propellant grain stability against boot-strapping.

This paper details the FSI analysis work done for ETM-3. The analyses conducted and documented in this report assumed linear elastic material behavior and steady state fluid behavior without time response in either the structural or fluid models.

© 2003, ATK Thiokol Propulsion, a division of ATK Aerospace Company

**DISTRIBUTION STATEMENT A**  
Approved for Public Release  
Distribution Unlimited